Susitna-Watana Hydroelectric Project (FERC No. 14241)

Cook Inlet Beluga Whale Study Plan (Study 9.17)

2015 Implementation Plan Technical Memorandum

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation or Symbol	Definition
CIBW	Cook Inlet beluga whale
PRM	Project river mile
~	approximately

1. PURPOSE

On December 14, 2012, Alaska Energy Authority (AEA) filed with the Federal Energy Regulatory Commission (FERC or Commission) its Revised Study Plan (RSP), which included 58 individual study plans (AEA 2012). Section 9.17 of the RSP described the Cook Inlet Beluga Whale Study. The study plan focused on the methods for locating, describing, and assessing Cook Inlet Beluga Whales (*Delphinapterus leucas*; CIBW) within the Susitna River delta, which may be affected as a result of Project construction and operation. RSP 9.17 provided goals, objectives, and proposed methods for data collection regarding CIBW.

On February 1, 2013, FERC staff issued its study plan determination (February 1 SPD) for 44 of the 58 studies, approving 31 studies as filed and 13 with modifications. RSP Section 9.17 was one of the 31 studies approved with no modifications.

Based upon evaluation the overall effectiveness of the methods implemented during the 2013 study season and the 2014 pilot study, AEA has developed significant modifications to this study's methods for the activities that will occur in 2015.

Given the scale of modifications to the Study Plan, AEA developed a Modified Revised Study Plan (MRSP) which was provided as an appendix to the ISR Part C: Section 7 submission on June 3, 2014. That MRSP and Section 7 of the ISR indicated that an Implementation Plan (IP) for study activities in 2015 would be provided based on results of work conducted in 2014 which are summarized in Cook Inlet Beluga Whale Study (Study 9.17) 2014 Cook Inlet Beluga Whale Prey Study Implementation Technical Memorandum (LGL 2014). This IP describes new methods for study activities in 2015 compared to those described in the RSP (RSP Section 9.17.1). On August 7 and August 26, 2014, AEA discussed 2014 activities and plans for 2015 activities with representatives of the National Marine Fisheries Service (NMFS). NMFS representatives provided informal feedback during those discussions and that input has been incorporated into this IP.

2. BACKGROUND

2.1. Existing Information and Need for Additional Information

The CIBW was listed as an endangered species under the ESA in October 2008 (73 FR 62919) and critical habitat for CIBWs was designated in April 2011 (76 FR 20180). When determining critical habitat, NMFS also identified the following five primary constituent elements (PCEs) essential to the conservation of the CIBWs:

1. Intertidal and subtidal waters of Cook Inlet with depths <30 feet (mean lower low water; MLLW) and within 5 miles of high and medium flow anadromous fish streams.
2. Primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole.
3. Waters free of toxins or other agents of a type and amount harmful to CIBWs.
4. Unrestricted passage within or between the critical habitat areas.

5. Waters with in-water noise below levels resulting in the abandonment of critical habitat areas by CIBWs.

Based on these criteria, NMFS identified two specific marine area types in Cook Inlet that contained one or more PCEs. Type 1 critical habitat encompasses 1,909 square kilometers (738 square miles) of Cook Inlet northeast of a line from the mouth of Threemile Creek to Point Possession. Type 1 critical habitat has the highest concentrations of beluga whales from spring through fall. Type 2 critical habitat consists of 5,891 square kilometers (2,275 square miles) of known fall and winter use areas. It is located south of Type 1, and includes nearshore areas along the west side of the Inlet and Kachemak Bay on the east side of the lower inlet. Type 1 critical habitat extends into the Susitna River an estimated 8.6 nautical miles from MLLW.

2.1.1. Distribution

Cook Inlet beluga whales reside in Cook Inlet year-round, which makes them geographically and genetically isolated from other beluga whale stocks in Alaska (Allen and Angliss 2014). Given their limited geographic range, changes in environmental conditions, including temperature and prey distributions among others, have the potential to influence CIBW distribution within the Inlet. Since the early 1990s, a variety of studies have been conducted to assess CIBW spatial and temporal distribution. Beginning in 1993, aerial surveys have been conducted annually or bi-annually by NMFS-National Marine Mammal Laboratory. These surveys have been flown annually in June and August with the focus of survey effort concentrated along northern, coastal waters of the Inlet (within 1.5 kilometers [0.9 miles] from shore) and a reduced survey effort in the middle and southern portions of the Inlet (NMFS 2008; Hobbs et al. 2011). Historic aerial surveys for beluga whales also were completed in the late 1970s and early 1980s (Harrison and Hall 1978; Murray and Fay 1979; Harza-Ebasco 1985). Results indicate that prior to the 1990s belugas utilized areas throughout the upper, mid, and lower Inlet during the spring, summer, and fall (Huntington 2000; Rugh et al. 2000; NMFS 2008; Rugh et al. 2010). The distribution has since contracted northeastward into upper Cook Inlet, which is especially evident in the summer range (Rugh et al. 2000; Speckman and Piatt 2000; Hobbs et al. 2008; NMFS 2008; Rugh et al. 2010). The distributional shift coincided with the decline in abundance, and suggests the remaining belugas are congregating in preferred habitat (Moore et al. 2000; Goetz et al 2007; NMFS 2008; Goetz et al. 2012a). Belugas seem to favor only a few of the many rivers in Cook Inlet, which are not necessarily those with the largest fish runs (Rugh 2000; Rugh et al. 2005; NMFS 2008). The whales may, in part, rely on feeding areas with appropriate topography and fish density (NMFS 2008). Understanding habitat selection is vital to the sustainability and recovery of the population (Goetz et al. 2012a).

The Susitna River delta in upper Cook Inlet may be a calving ground for CIBWs (Huntington 2000) and seasonal use of the Susitna mudflats by CIBWs has been well documented (McGuire et al. 2009, 2011a, b; Hobbs et al. 2012). Pregnant or lactating female belugas may depend upon eulachon and salmon runs in the Susitna River to meet increased energetic demands (Goetz et al. 2012a). Also, the warmer waters of the Susitna River may be important to neonate body temperature regulation (NMFS 2008).

CIBWs have been documented upriver in Cook Inlet tributaries during spring, summer, and fall. CIBWs have been observed upstream in both the east and west channels of the Susitna River. Traditional knowledge tells us that whales occasionally swim as far as 30-40 mi upriver on the spring tide, but are more likely within 5 miles of the mouth when utilizing the east channel.

Their range in the west channel is more limited, traveling less than 5 mi upstream (Huntington 2000). Site-specific data on use of the Susitna River above the delta is limited.

CIBWs have also been reported swimming up Beluga River and into Beluga Lake, 30 mi from the river mouth. In addition, the smaller creeks and rivers between the Beluga River and the Susitna River appear to be suitable habitat. It is thought that these excursions into tributaries are associated with foraging on prey species. Because these whales are likely following prey species into river habitats, any Project-related impacts to prey species abundance, run timing, and/or density have the potential to cause indirect impacts on CIBWs (PCE 2).

2.1.2. Prey Species

Cook Inlet belugas are opportunistic and feed on a wide variety of prey, targeting specific species when they are seasonally abundant (Hobbs et al. 2006; NMFS 2008). Seasonal movement patterns and site fidelity of CIBWs, therefore, appear to be closely linked to prey availability. In particular, whale movement patterns coincide with seasonal eulachon and salmon concentrations (Moore et al. 2000). Stomach content analyses indicate that eulachon is a key prey resource in the spring. As eulachon runs begin to dwindle in the summer, belugas switch to salmon and rely heavily on several species (Huntington 2000; Hobbs et al. 2006; NMFS 2008). The timing, location, and abundance of these fish runs can be elemental to beluga whale distribution.

CIBWs have been documented upriver in Cook Inlet tributaries during spring, summer, and fall. As described above, CIBWs have been occasionally observed as far as 30-40 mi upstream of the Susitna River, but predominantly within the lower five miles (Huntington 2000). Prey species (eulachon and salmon) could potentially be impacted from changes in water quality (i.e., temperature) that have the potential to affect adult migration timing as well from changes in hydrology and geomorphology that could affect available mainstem spawning habitat (eulachon). Changes in the timing, duration, or magnitude of fish migrations could affect CIBW foraging and thus reproductive success due to the high energetic demands of pregnant and lactating females and temporal variation in their presence in the Susitna River. It is, therefore, important to collect baseline information on CIBW prey species that will facilitate future analysis of potential Project impacts.

2.2. Study Activities to Date

As described in detail in the Study 9.17 ISR Sections 4, 5, and 6, the first season of research, conducted from May through October 2013, included aerial surveys of the Susitna River delta and the use of digital still and video cameras to document CIBW use in the Lower Susitna River. Various logistical and technical issues limited the duration of time the camera systems were in place and operating. During video sampling between September 3 and 24 at Project River Mile (PRM) 6, CIBWs were sighted nine times; seven sightings (of likely the same group) on September 20 and two on September 22. A single group of one white individual and one gray individual was captured in a still photograph on September 4, also at PRM 6. No beluga whales were photographed by still cameras positioned from PRM 11 through PRM 16. Given these observations, additional information is needed to describe specifically how and when the CIBWs use Susitna River habitats.

Seventeen aerial surveys were conducted between May 6 and October 11, 2013. Six surveys were flown during high tide, six during low tide and five during the intermediate tide between high and low. CIBWs were sighted during 12 of the 17 aerial surveys, including all surveys between May 6 and August 30, except for an incomplete survey on June 27. Although surveys were flown into October, no CIBWs were observed in the Susitna River delta after the survey on August 30. Locations of CIBW sightings varied among flights, with most sightings occurring within two miles of the Cook Inlet shoreline in the Susitna River delta (between the Beluga and Little Susitna rivers). The number of CIBW groups observed during each survey ranged from zero to nine and the monthly sighting rate of CIBW groups (among months that had any sightings) was highest in July and August and lowest in June. Measured on an individual whale basis (i.e., CIBWs observed per hour of survey effort), sighting rates increased steadily from May to July and were highest from July to August. The observed spatial distribution is generally consistent with previous studies that included the survey area during a similar timescale (e.g. Rugh et al. 2004; Goetz et al. 2012b; Sims et al. 2012; Shelden et al. 2013). The temporal pattern of abundance is consistent with other studies that also showed increased presence of CIBWs in the Susitna River delta in May and June, and again in mid- July through August (Hobbs et al. 2005; Funk et al. 2005; McGuire et al. 2008, 2009, 2011; McGuire and Kaplan 2009; McGuire and Bourdon 2009, 2012). These patterns are likely in response to seasonal migrations of fish (NMFS 2008).

In 2014, a pilot study was conducted to determine if vessel-based surveys combining simultaneous data collection on CIBW prey and CIBW distribution, behavior, and group composition could fill data gaps from the 2013 study (LGL 2014). Prey density and marine mammal observations were recorded during nine surveys in June and July in the Susitna River delta. A split beam sonar was operated during each survey to document bathymetry and prey species abundance. Some channels or holes were identified in the central Susitna River Delta, but few fish were detected. Fish densities were much higher on low tide surveys at the edge of the Susitna Flats than on high tide surveys closer to the Susitna River mouth. CIBW sightings and group size were much higher in July than June, although there was no difference in group composition between these months. There was a temporal relationship between fish density and CIBW sightings in July when fish densities were higher overall. While surveys in 2014 were successful in detecting fish and marine mammals, the timing of the surveys and weather restrictions affected the ability to collect data on a regular basis. Additionally, the vessel could not intentionally approach whales to characterize the bathymetry and the fish density in close proximity to CIBW groups due to the risk of harassment. For those reasons, the methods used in 2014 are not planned to be implemented in 2015 activities.

2.3. Objectives

As described in the RSP for Study 9.17, the goals of this study are threefold: (1) to provide current, fine scale information on Cook Inlet Beluga Whale (*Delphinapterus leucas*; CIBW) distribution and movements within the Susitna River delta, (2) to correlate these data with information on the ecology and habitat parameters of CIBW prey species, including eulachon and Pacific salmon, and (3) to record incidental observations of all marine mammals sighted during beluga whale studies. Three specific objectives were identified including:

1. Document CIBWs and other marine mammals in the Susitna River delta, focusing on CIBW distribution and upstream extent.

2. Document CIBW group size, group composition, and behavior within the Susitna River delta.
3. Develop a model to describe the relationships between river flows, water surface elevation, and CIBW foraging habitats in the Susitna River.

The results of aerial and vessel surveys in 2013 and 2014 are consistent with previous and ongoing studies in the Susitna River delta. Extensive survey effort for similar data, such as the aerial surveys flown annually by the National Marine Mammal Laboratory (NMML) and photo-ID surveys funded by NMFS, continues to be conducted, and it is not the intent of 2015 activities to reproduce these efforts. Thus, it is not necessary to collect further data to address objectives 1 and 2 of Study 9.17, except for documenting CIBW use of the Lower Susitna River. Activities in 2015 will therefore focus on CIBW distribution and group composition in the Lower Susitna River.

To achieve objective 3 and fill other data gaps necessary for addressing potential impacts on CIBW, additional activities will be conducted as a part of other studies in 2015 (Study 8.5 and 9.16). Tetra Tech (2014) showed that below PRM 29.9, long-term hydrology, hydraulics, sediment transport, and channel geomorphology changes from Project operations would be small compared to the large range of natural variability. Because change in stage over specific periods will primarily result from changed river discharge, AEA recommended that fluvial geomorphology modeling (including associated 1-D hydraulic modeling and tidal hydrodynamic modeling) not be extended below PRM 29.9. Stage and tide data will, however, be collected in the Lower River using pressure transducers co-located with surveyed cross sections. The pressure transducer study and associated stage height modeling will provide input data on water surface elevations for a wetted perimeter analysis to determine whether the streambank geometry and substrate provide acceptable spawning conditions for eulachon as the water level varies along the shoreline in response to potential Project effects on flow in the Lower Susitna River (see proposed modification to Eulachon Study 9.16 (R2 2014).

Information from the following studies will be synthesized with the beluga whale study results to provide an ecologically based description of beluga whale distribution and habitats. The Salmon Escapement Study (Study 9.7) and Eulachon Run Timing, Distribution and Spawning in the Susitna River Study (Study 9.16) will provide information on the distribution of beluga whale prey species in the Lower River while the Baseline Water Quality Study (Study 5.5), Water Quality Modeling Study (Study 5.6), Geomorphology studies (Studies 6.5 and 6.6), and the Fish and Aquatics Instream Flow Study (Study 8.5) will provide information on physical and chemical processes that may influence riverine habitats and through that have possible indirect effects on the distributions of CIBWs and their prey species. Additionally, Eulachon Study (9.16) will place pressure transducers and collect stage height information in the Lower River to conduct a wetted perimeter analysis to determine whether the streambank geometry and substrate provide acceptable spawning conditions for eulachon as the water level migrates in and out along the shoreline in response to potential Project effects on flow in the Lower Susitna River (R2 2014). Collectively, this information will be used by FERC in its National Environmental Policy Act (NEPA) and licensing processes, for the NMFS Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) reviews, and for the development of potential protection, mitigation, and enhancement (PM&E) measures.

3. STUDY AREA AND TIMING

The study area encompasses the Susitna River mouth upstream to the upper extent of CIBW distribution. Vessel-based observations incidental to the Eulachon Study (9.16) will occur from approximately PRM 6 to PRM 50, and take place in May through mid- June. Land-based observations will focus on CIBW presence and group composition in the lower Susitna River between approximately PRM 6 and PRM 20. Land-based observations will occur from breakup until early October. Weather permitting, observation stations will be staffed every day from breakup through the eulachon spawning run, and every day from July 15 through August 15 during peak use of the Susitna River Delta by CIBW coincident with Pacific salmon spawning runs. During all other periods, observation stations will be staffed 2-3 days per week, weather permitting.

4. METHODS

4.1. Land-based CIBW Observations

Land-based observations are appropriate to document the occurrence of CIBWs in the Susitna River at specific locations. Land-based observers will provide continuous data over longer time periods than aerial or vessel-based surveys and allow for data collection without disturbing study animals (Funk et al. 2005; McGuire and Bourdon 2009; Cornick et al. 2010).

4.1.1. Survey stations

Two survey stations will be established along the Susitna River. Site evaluations must still be completed, but it is likely that one survey station would be located on Big Island at approximately PRM 6 where live-feed video cameras were installed in 2013. An additional survey station will be placed farther upriver downstream of PRM 20. The specific location of survey stations will be dependent upon accessibility, field-of-view, permits and co-location with instruments from other studies. If necessary, temporary elevated platforms for observations may be constructed to enhance the observer's field-of-view. Weather permitting, survey stations will be staffed seven days a week during peak CIBW use of the Susitna River delta. These intensive periods will include from breakup through the eulachon run and July 15 through August 15 during Pacific salmon spawning runs. At other times between May and October, the observation stations will be staffed two to three days per week, weather permitting.

4.1.2. Data collection

On days when observation stations are staffed, two observers will be assigned to each station for an 8-10 hour monitoring period. Observers will use hand-held binoculars and the naked eye to search for belugas. Observers will record environmental data, marine mammal sighting data, and take high resolution photographs when possible. Data will be recorded in real time using electronic data entry software. In addition, post-processed data will be presented in monthly reports that reflect monitoring effort and beluga whale activity (presence, group size, location, composition) as well as environmental conditions. While not the focus of this study, if any

photographs were high quality enough to be used for photo-identification purposes, AEA will provide this information in the CIBW photo-ID catalogue.

4.1.3. Environmental data collection

Environmental data will be collected at the beginning of the survey, at the end of the survey, and once every 30 minutes during the survey, or sooner if conditions affecting visibility change rapidly. Environmental data are collected using custom-built data entry software.

- Position of observers;
- Visibility, sun glare, sea state, precipitation;
- Positions of other marine mammals or humans (including vessel traffic) in the vicinity of the observer location;

4.1.4. Sighting data collection

The following information will be recorded at the beginning, end, and at five minute intervals during each CIBW sighting. Sighting data recorded includes:

- species, group size, age/size categories;
- general behavior of the group and specific behavior of individuals;
- group formation and spread;
- location, bearing, and distance from observer;
- apparent reaction if human activities are occurring (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace; and
- positions of other marine mammals or humans (including vessel traffic) in the vicinity of the observer location.

Sighting data will be collected using a combination of electronic data entry software and paper datasheets. Observers will capture a timestamp at the beginning of a sighting as well as generate a unique Sighting ID. For each 5 minute sampling or resight during a sighting, a unique Record ID will be created. To record the location of CIBWs, the study area will be divided into segments using a numbered grid covering the station's field-of-view. When beluga whales are present, observers will record the group location by grid number and any changes in grid location as a result of movement or behavior.

4.1.5. Group Counts

Upon sighting a group of whales, one observer will conduct focal group sampling, while the second observer will continue to scan the study area for the presence of other groups of whales. The goal of focal group sampling is to extract the most information possible from the group without compromising data from additional groups. Once a group enters the field-of-view, one observer will begin focal group sampling and will remain focused on that group for as long as is possible given the time of observation within the monitoring period, the presence of other CIBW groups or other marine mammals, and environmental conditions.

Each whale sighting will be assigned two identification numbers: a "day group" number that reflects the actual order of when a specific group was detected that day and an "archive group" that defines the group and thus, remains constant for all sightings during the study period. For example, a group sighted four times in one day would be assigned "day group" numbers of 1, 2, 3, and 4, and if it is the first unique group of that day the "archive group" number would be 1. If a single group of whales splits into distinct segments, letters would be used to denote archival subgroups of the same parent group (e.g., 1a, 1b, etc.). The only time that an archival group number would change is if two known groups merge into one. In such an instance, e.g., Group 1 joins Group 2, the combined group would be given the archive group number of the group that joined, in this case, Group 2. This method of documentation allows for detailed tracking of animal groups, movements, and interactions without inflating animal numbers.

For reporting purposes, beluga whale sightings would be in reference to archive groups in order to accurately reflect the total number of groups and individuals observed. Sightings data such as behavior, composition, and/or location would be reported by "day group" in order to reflect dynamic changes within the study area by a single group.

4.2. Vessel-based Incidental Observations

Each of AEA's Project studies are responsible for reporting incidental CIBW sightings that occur during study activities, but meaningful conclusions cannot be made without records of observational effort. Coordination with on-water activities for Study 9.16 will provide an opportunity to link incidental observations of CIBWs with on-water effort in the Lower River. Biologists will already be present on the Lower River for Study 9.16 and they will be trained to document observational effort and presence of CIBW in the Susitna River during Study 9.16 activities.

4.2.1. Environmental Data Collection

Environmental data will be collected on paper datasheets at the beginning and end of vessel transits along the river and observers will make notes if conditions affecting visibility change rapidly. A GPS will be present on the vessels and observation effort will be extrapolated from the trackline. Data to be collected include:

- time and location of departure and arrival;
- visibility, sea state, precipitation; and
- presence of other human activities on the water.

4.2.2. Sighting Data Collection

Observers will collect data for any CIBWs observed incidentally during vessel operations. Sighting data recorded will include:

- Time at the beginning and end of each sighting;
- species, group size, age/size categories;
- general behavior of the group (if any);
- heading, bearing, and distance from vessel; and

- apparent reaction to vessel or other human activities (e.g., none, avoidance, approach, paralleling, etc.), and behavioral pace.

Sighting data will be collected using paper datasheets. Photographs of each sighting will be taken when possible.

4.3. Consistency with Generally Accepted Scientific Practices

The study methods presented here are consistent with methods commonly followed in investigations of CIBW. Land-based visual observations of CIBW have been conducted to document whale usage of, and potential reactions to anthropogenic activities at, a number of locations in Upper Cook Inlet including Knik Arm (Funk et al. 2005; Prevel-Ramos et al. 2006; Cornick et al. 2010), Turnagain Arm (Markowitz et al. 2007), Fire Island (McGuire and Bourdon 2009), and near Tyonek (Nemeth et al. 2007; Prevel-Ramos et al. 2008).

4.3.1. Relationship with Other Studies

The Cook Inlet Beluga Whale Study will interrelate with at least seven of AEA's other Project studies. The flow of information into the CIBW Study is anticipated to occur over the entire study period through an iterative process. As previously discussed, all Project studies report incidental CIBW sightings and coordination with Study 9.16 will connect vessel effort and sightability with any incidental CIBW sightings recorded.

Information from the following studies will be synthesized with the beluga whale study results to provide an ecologically based description of beluga whale distribution and habitats. The Salmon Escapement Study (Study 9.7) and Eulachon Run Timing, Distribution and Spawning in the Susitna River Study (Study 9.16) will provide information on the distribution of beluga whale prey species in the Lower River while the Baseline Water Quality Study (Study 5.5), Water Quality Modeling Study (Study 5.6), Geomorphology studies (Studies 6.5 and 6.6), and the Fish and Aquatics Instream Flow Study (Study 8.5) will provide information on physical and chemical processes that may influence riverine habitats and through that have possible indirect effects on the distributions of CIBWs and their prey species. Additionally, Eulachon Study (9.16) will place pressure transducers and collect stage height information in the Lower River to conduct a wetted perimeter analysis to determine whether the streambank geometry and substrate provide acceptable spawning conditions for eulachon as the water level migrates in and out along the shoreline in response to potential Project effects on flow in the Lower Susitna River (R2 2014). Information from these studies will be used for the environmental analysis that will be prepared in support of AEA's FERC License Application. Additional formal data sharing will occur among studies after completion of QA/QC procedures with the delivery of the Updated Study Report (February 2016).

5. SCHEDULE AND DELIVERABLES

The anticipated field schedule for 2015 will last from breakup until early October. The schedule for incidental observations of belugas from Study 9.16 vessels will be determined by the schedules of that study, but primarily occur from May through late June. Land based visual observations will occur from May until October. More observation effort will occur when CIBW use of the Susitna River Delta is most prevalent and the likelihood of use of the Lower

Susitna River is expected to be highest. These times coincide with the eulachon run in spring and during the salmon run and CIBW calving period in mid- summer. Thus, land-based observations are planned 7 days a week, weather permitting, from breakup until the end of the eulachon run and from July 15 to August 15. Land-based observations will occur approximately two to three days a week during all other times and through early October.

Quality Assurance (QA)/Quality Control (QC) reviews of the data analyses will be completed by the end of 2015. Reporting will be completed in the February 2016 Updated Study Report.

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7. FIGURES

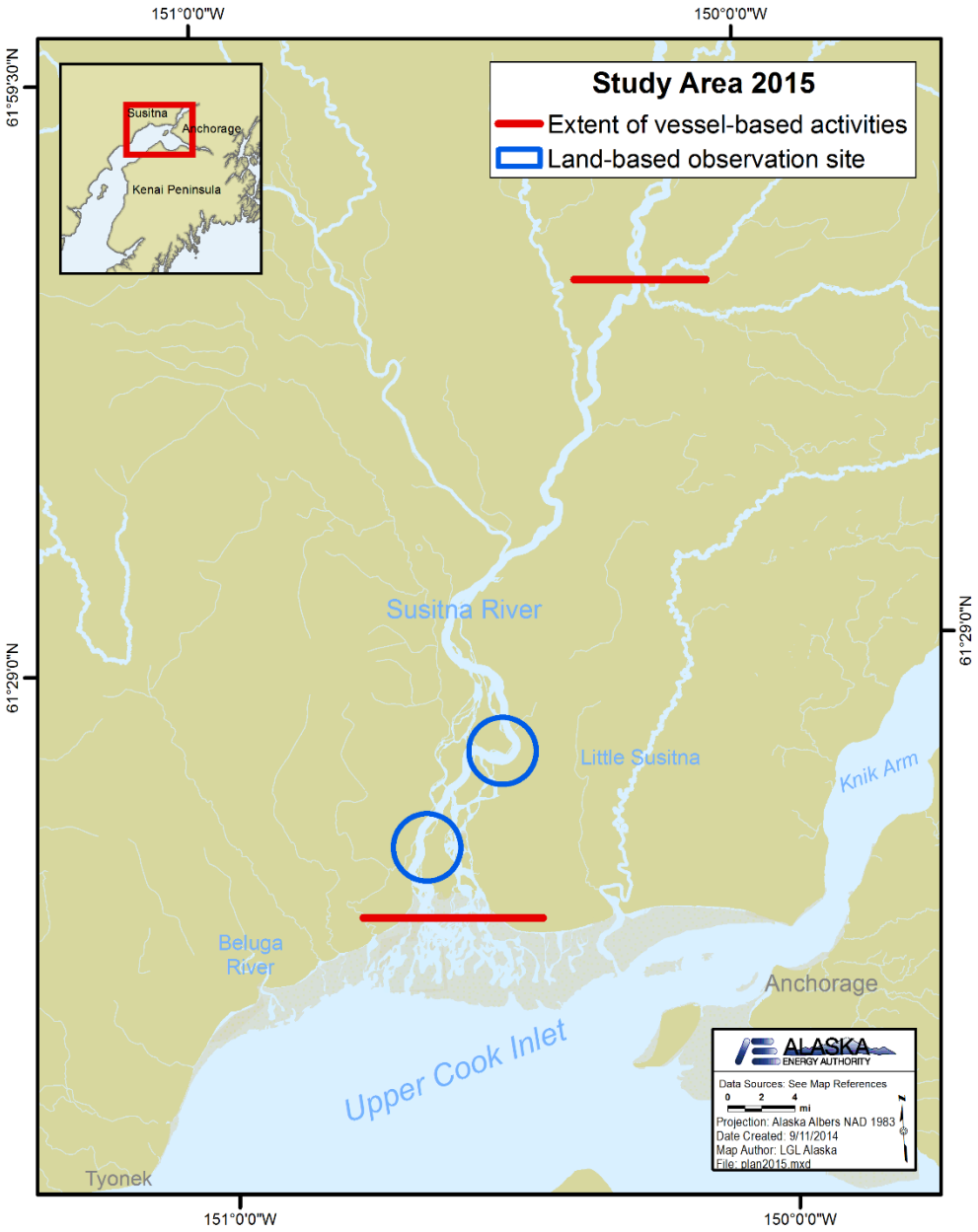

Figure 1. Study area for Cook Inlet Beluga Whale Study vessel- and land-based observations.